

REMARKS/ARGUMENTS

Introductory Remarks:

Claim 1-33 are pending in this Application, and had previously been made subject to a Restriction Requirement. The Requirement was based on the division of the claims into two groups: Group I, containing claims 1-15 and 17-33, drawn to a composition; and Group II, containing claim 16, drawn to a casting investment mold. (Page 2 of the Office Action, line 5, indicates that claim 17 is part of the second group, rather than claim 16, but Applicant believes that is a typographical error. The same assumption is made for page 7, line 4, i.e., in regard to claim 16). According to the Office Action, a provisional election of Group I was made on January 18, 2006. By this document, Applicant affirms that election.

However, Applicant continues to maintain that Groups I and II are part of a single inventive concept which can be searched and examined in unitary fashion, without undue burden to the Patent Office. Claim 16 is clearly a product of the process of claim 1. This product contains a number of unique characteristics which will be discussed below in greater detail. The undersigned does not completely understand the Examiner's point regarding the scope of claim 16 and the process of claim 28, since the two claims have no relation to each other. Moreover, the point regarding anticipation of claim 16, in regard to the portion of the Restriction argument on page 3, is also not easily understood. (Review of these points by way of a telephone discussion with the Examiner would be welcome, in order to allow the undersigned to perhaps comprehend the issues to a greater degree). In regard to comparative scope, Applicant notes only that claim

16 is no broader than the scope of claim 1. In that light, the use of the “intermediate product” for applications (e.g., the thermal interface sheets) other than that recited in claim 16 does not seem to be a justification for a Restriction. Therefore, Applicant requests that the Requirement be reconsidered.

### Claim Objections

Claim 19 has been objected to because of the use of the term “free of solvent”. Applicant has reviewed the language in terms of normal grammatical and usage standards. Although the Examiner’s suggested, alternative language seems to be acceptable, it also appears equivalent to the current language. The language can be readily changed after other substantive issues are addressed, if that course of action is acceptable to the Examiner.

Claim 30 has also been objected to, as the Examiner states that the language of the claim is somewhat unclear, in regard to the sequence of process steps. Applicant submits that the chronological position of each step is clearly described in the specification. For example, paragraph 44 (last two sentences) and paragraph 45 describe the optional use of a solvent, while also describing the heating step which can be undertaken to remove the solvent from the green product. In general, the solvent-removal step/drying step, sometimes carried out at a range of room temperature to about 100°C, is carried out after formation of the green body (through polymerization and cross-linking), but prior to exposure of the body to higher temperatures employed to sinter and/or cause char formation. However, there is much variation in the overall process sequence. As but one example, the solvent-removal/drying step could be a separate step from the sintering/char formation step; or the two steps could be part of a single, continuous

regimen of increasing temperature. While the undersigned has not made a specific change to claim 30 at this time, some additional, clarifying language could be inserted without difficulty, upon resolution of the other substantive issues in this prosecution.

Claim Rejections – 35 U.S.C. 112

Claims 1-15 and 17-33 have been rejected under Section 112, second paragraph, as being indefinite. The first point regarding this rejection relates to the description of the green product. The product is based on a silicone monomer/oligomer which contains at least one alkenyl reactive functional group and/or at least one hydride reactive functional group. The Examiner's position appears to be that the current language in claim 1 (and some related claims) implies that the alkenyl functionality and the hydride-reactive functionality need to be part of the same molecule, while other claims seem to imply that these groups can be present on different molecules.

The undersigned professes that some clarification might be helpful, but that he is unsure of the Examiner's specific objection to the claim language. The Examiner is correct in regard to the intended scope of the claims. In other words, the inventors intended that, in the broader scope of their invention, the silicone monomers/oligomers could contain the two types of reactive groups (alkenyl and hydride-reactive) in a single molecule, or in different molecules. Thus, Applicant is in full agreement with the Examiner's assumption (page 5 of the Office action) that "...no one molecule has to be the source of both...groups...". While the undersigned maintains that all of the claims in the

case are consistent with this assumption, he would readily entertain suggestions on how to clarify any particular claim at issue.

Moreover, Applicant wishes to emphasize another point, regarding the functional groups. While claim 1 recites the requirement that the silicone monomers/oligomers must contain an alkenyl reactive functional group and a hydride reactive functional group, many different embodiments are possible. For example, multiple groups of each type may be present on the monomers/oligomers. As an illustration, claim 3 describes the presence of at least three of each type of group being present. Moreover, in that claim, Applicant emphasizes the fact that either three alkenyl reactive groups or three hydride reactive groups are present. The inventors intended this meaning, and not one in which both sets of reactive groups always had to be present.

The Examiner made another point, in regard to the variable "X", as recited in claim 18. X is said to be a divalent hydrocarbon radical which can be between 0 and 8. The Examiner states that it is unclear why there would be more than one divalent radical, e.g., in regard to radicals being strung together in head-to-tail fashion.

The language in question has been reviewed with one of the inventors. The expression of the alkenyl functionality ( $X_a$ ) in claim 18 is perfectly correct, but perhaps awkward. In other words, X could be in the form of a multitude of divalent groups attached to each other along a linear or branched chain. Moreover, X could have been expressed in other ways as well. As a non-limiting example, X could have perhaps been expressed as  $(CR_2)_a$ , where R is hydrogen or a hydrocarbon, and a is 1-8. (In some embodiments, "a" might be deemed superfluous). Further discussion with the Examiner on this particular

point might be helpful, to confirm that the language, as explained herein, is clear; or to discuss ways to change the language.

Claim Rejections – 35 U.S.C. 102

Claims 1-5, 8-14, 17-19, 21-25, 27-28, and 30-33 have been rejected under 35 U.S.C. 102(b), as being anticipated by a patent issued to K. Mine et al, U.S. 4,269,753 (“Mine”). It appears to be the Examiner’s position that Mine’s “ceramifiable composition” meets the limitations present in the rejected claims. Applicant responds by emphasizing that there are significant limitations in the claims at issue, which are not present in the Mine reference.

An appropriate beginning to this discussion might involve a brief review of some of the key aspects of the present invention. Some of the chief embodiments relate to a green product used in the fabrication of a ceramic part, such as a casting mold or casting core. A ceramic powder is contained within a silicone matrix, which itself is based on one or more cross-linked or polymerized silicone monomers and/or oligomers. The silicone materials must contain an alkenyl reactive functional group and a hydride reactive functional group.

The “design” of the ceramic-silicone system is very important to the successful casting of the ceramic articles. The quality of castings like molds and cores is, in turn, critical to the formation of sophisticated, high-temperature articles, such as gas turbine blades and nozzles made from superalloys. (See paragraphs 2 and 3 of the specification). As an example, ceramic cores for investment casting are advantageously made from materials which are very amenable to certain forming processes, like extrusion, injection molding, and the like. It is sometimes extremely preferable that these types of materials initially

have a very low viscosity. (See paragraph 37). However, after being polymerized and/or cross-linked, the resulting “green” products need to exhibit high strength and toughness. Moreover, the material needs to be able “grow” in molecular weight after it is formed into the core, i.e., at a point where viscosity is no longer an issue. The resulting material should exhibit a char yield high enough to minimize shrinkage. Otherwise, shrinkage could result in a core with unsuitable mechanical properties for the casting of materials like superalloys. (See paragraph 7, first sentence; and paragraph 15, last sentence).

The prior art had struggled in the search for a silicone material which has a liquid-like viscosity required for molding, but which can be polymerized into a firm, strong green body, and then fired into a part which exhibits minimal shrinkage. The materials recited in the pending claims represent one key discovery of that search. These materials are provided with a high degree of reactivity, i.e., via certain alkenyl and hydride functional groups (see, for example, claims 1, 3 and 13). Moreover, a variety of ceramic powders can be incorporated into a matrix of the polymerized material (see claims 5 and 6). In some cases, the silicone monomers and oligomers preferably constitute about 50—75 volume % of the green body (see claim 7).

Some specific examples of the hydride functional groups are provided in claims 8 and 14, while examples of some of the specific alkenyl functional groups are recited in claims 9-10 and 15. Moreover, claim 11 recites a preferred viscosity limit for silicone materials being formed into the green product. Claim 17 specifically recites the green product in the form of an investment casting core.

Claim 18 is directed to the process of forming the green product, using the particular monomers/oligomers discussed previously. As recited in claim 19, the process is preferably carried out in the absence of solvent, since the presence of solvents can sometimes cause serious problems (see paragraphs 8 and 18). Other method claims are directed to various features of the process, e.g., the use of specific families of starting materials. Claim 28 and claims dependent therefrom recite the process for making a ceramic core, using the unique silicone materials described in the specification.

The Mine patent is directed to a composition based on a siloxane copolymer consisting essentially of  $R_3SiO_{1/2}$  units and  $SiO_{4/2}$  units, along with an organopolysiloxane having at least two hydrogen atoms bonded to silicon, per molecule; a ceramic filler; and a catalyst. (See col. 1, line 66 to column 2, line 23). The composition can also contain another organopolysiloxane polymer (component "B"), which contains at least two unsaturated groups bound to silicon atoms, per molecule. The "R" group in the copolymer contains 1-10 carbon atoms, along with at least two unsaturated groups. The composition is used for elastomers or other resinous materials which can be polymerized and "ceramified" to form insulating coatings for wires (e.g., col. 6, lines 44-46).

While Mine is certainly directed to the broad field of siloxane compositions which contain ceramic materials, it does not appear to contain all of the limitations present in various claims at issue here. For example, the compositions of Mine do not appear to have the degree of functionality recited in claims 2 and 3, or embodied in the monomers/oligomers recited in claims 8 and 10. As discussed in the specification, high functionality is critical for achieving green products having the strength and toughness required for many casting applications.

The compositions of Mine also require the presence of alkoxy groups bound to silicon atoms (col. 2, lines 4-5).

Moreover, there is no clear indication that Mine is describing low viscosity silicone matrix compositions, as recited in claims 8 and 10-11, for example. The Examiner refers to the viscosity measurement for one particular component of the Mine compositions (col. 3, lines 51-56). However, Applicant submits that such a disclosure can in no way provide an indication of the viscosity for the entire silicone compositions. Furthermore, the constituent which forms the basis for the viscosity estimate (component (B)) is an optional material (col. 2, line 6, "0-600 parts"), employed as a viscosity-adjuster. There is too little information in the reference to make such a conclusion regarding viscosity – especially since the reference does not appear to have anything to do with the end uses contemplated for the present invention. In that regard, the end use embodied by an investment casting core (claim 17) is also not disclosed in Mine.

Applicant also submits that the process claims are not anticipated by Mine. Again, the reference does not appear to describe a process for making a green product, using very low viscosity, high-functional silicone monomers/oligomers. The patent also has nothing to do with fabricating a ceramic core, as recited in claims 28 and related dependent claims. Moreover, Applicant does not believe Mine specifically describes a process carried out in the absence of solvent, as recited in pending claim 19. The undersigned has reviewed the referenced language in column 5 of the patent, but submits that the wording is not definitive as to the optional presence of solvent. Moreover, the examples (beginning in col. 6) appear to be using one or more solvents (isopropyl alcohol at



lines 32-33). Applicant thus submits that Mine does not anticipate all of the claims listed in the rejection.

Claims 1, 3-5, 8-9, 11-12, 17 ("16"), 18, 21, 23-25, 28-29 and 32-33 have been rejected under 35 U.S.C. 102(b), as being anticipated by a patent issued to W. Atwell et al, U.S. 4,888,376 ("Atwell"). The patent relates to highly densified ceramic bodies, made by combining silicon carbide powder with an organopolysiloxane curing agent, an organopolysiloxane, and a sintering aid. (See col. 1, line 63 to col. 2, line 1). A variety of organopolysiloxanes can be employed, including those which contain units or groups like  $R_3SiO_{0.5}$ ,  $R_2SiO$ ,  $RSiO_{1.5}$  and  $SiO_2$ , wherein each R can be hydrogen, an alkyl radical, a phenyl radical, or a vinyl radical (col. 4, lines 10-14). A further description in column 4 is directed to more specific organopolysiloxanes. Some of the organopolysiloxanes contain both vinyl groups and hydrogen atoms attached to silicon (col. 5, lines 47-50). The organopolysiloxane materials must be capable of being converted to a ceramic material with a char yield of greater than 20 weight % (col. 3, lines 46-51).

While Atwell certainly describes curable organopolysiloxanes, the reference fails to meet other limitations in the claim. For example, while there is some mention of vinyl groups and what might be termed hydride reactive groups, Atwell appears to fail to disclose compositions with the high degree of functionality recited in claim 3, or in claims 8 and 10. Atwell never discloses a green product made from silicone monomers/oligomers having very low viscosity, as in the present invention. (The patent describes the use of low viscosity fluids, e.g., col. 19, last line, to col. 20, line 2. However, those materials appear to be

used only as viscosity-control components for the overall organopolysiloxane compositions).

Atwell is also directed to components in which the ceramic constituent must be silicon carbide. The reference never discloses the use of other ceramic powders claimed for the present invention (e.g., see claims 5 and 6), such as alumina, fused silica, zirconia, and the like. Moreover, Atwell has nothing to do with investment casting cores, as recited in claim 17.

The process claims of the present invention also do not appear to be anticipated by Atwell. Clearly, the patent describes the preparation of organopolysiloxane compositions, and some of the starting monomers/oligomers may contain functional moieties like vinyl groups. However, Atwell never discloses the preparation of curable polymers, using starting materials with the high level of functionality recited in some of the pending claims. Moreover, Atwell does not appear to ever describe the preparation of the organopolysiloxane materials in the absence of solvent, as recited in claim 32. (For example, Examples 1 and 5 rely on the use of solvents such as toluene and isopropanol). Atwell also fails to disclose the preparation of a ceramic core, as recited in claim 28. Thus, Applicant submits that the claims are not anticipated by this reference.

Claims 1-5, 9, 11-13, 17-19, 21, 24, 28-29 and 31-33 have been rejected under 35 U.S.C. 102(b), as being anticipated by Schilling, Jr. et al, U.S. Patent 5,162,480 ("Schilling"). The patent describes organopolysiloxanes having particular combinations of siloxane units, as set forth in column 2, lines 50-58. The silicone polymers contain both alkylhydrosiloxane and alkylvinylsiloxane units, and are siloxy-endblocked. (See col. 3, lines 41-44). The

organopolysiloxanes can contain various inorganic fillers, such as silicon carbide and silica. As the Examiner notes, the silicone starting materials are employed in an equilibrium process to produce the desired siloxane polymers.

Schilling describes a number of siloxane polymers, and some of them appear to include alkenyl groups and hydride reactive groups. However, the reference does not appear to disclose monomers/oligomers with the high level of functionality required for some embodiments of the present invention, as discussed previously. Moreover, the ceramic component appears to be optional (see col. 6, lines 29-34), and the scope of the possible ceramic constituents appears to be limited. Furthermore, the reference has nothing to do with ceramic cores, or methods for making them.

Moreover, the specific monomers covered by the Schilling patent appear to be those which are self-curing, as the Examiner has pointed out. In that regard, the reference never discloses a process in which silicone monomers/oligomers must be cross-linked or polymerized in the presence of a metallic catalyst – a key requirement for embodiments of the present invention (inter alia, claim 18). The Examiner appears to be inferring from examples in the patent that a metal catalyst must be present, since cross-linking is occurring. Applicant responds by emphasizing that the equilibration process described in the patent does not appear to rely on these types of catalysts. This is in marked contrast to embodiments of the present invention (see, e.g., paragraph 24 of the specification), where the metal catalyst is highly desirable for the reaction of the silicone alkenyl groups and the silicone hydride groups. When this key difference is combined with the other distinctions, Applicant submits that Schilling cannot be said to anticipate the claims at issue.

Claim Rejections – 35 U.S.C. 103

Claims 6 and 7 have been rejected under 35 U.S.C. 103(a), as being obvious in view of the Mine patent. First, it appears to be the Examiner's position that the specific ceramic powders recited in claim 6 would be readily suggested in the art, as would various combinations of the ceramics. In regard to the levels of silicone monomers/oligomers recited in claim 7, the Examiner indicates that the qualification in the claim is inherently satisfied when compared with (or extrapolated from) filler proportions described in Table 1 of Mine.

In regard to claim 6, Applicant asserts that the claimed group of ceramic powders is one which is especially preferred in the case of investment casting molds and investment casting cores. Mine has nothing to do with such an end use, and is instead specifically related to wire coating compositions. Moreover, the ceramic limitations of claim 6 must be viewed in conjunction with the limitations of other claims in the case, e.g., claims 5 and 1. As mentioned previously, Mine never suggests the highly functionalized, low viscosity silicone monomers/oligomers of the present invention.

In regard to claim 7, the undersigned respectfully disagrees with the analogy the Examiner appears to be making between Table 1 of the Mine patent and the specific language in the claim. As described in various sections of the present specification (e.g., paragraph 18), the level of silicone monomers/oligomers in the green product can be very important for obtaining the desired degree of hardness and strength in the green product. In the case of cores and shell molds used in casting precision parts such as turbine blades, the strength and stability of the core can be critical in the manufacturing process. Nothing in

Table 1 of Mine (or in other sections of the patent), suggests the specified levels of monomers and oligomers, or suggests a reason as to why such levels would be important. The end uses contemplated by the teachings of the patent – wire coatings – require very different types of properties, such as flexibility, crack resistance, and electrical insulation (e.g., col. 1, lines 33-37; col. 6, lines 36-48). The absence of similar “goals” for the respective inventions is a further indication that the claims at issue are not obvious.

Claims 2 and 31 have been rejected under 35 U.S.C. 103(a), as being obvious in view of the Atwell patent. The Examiner’s position is that it would be obvious to one of skill in the art to adjust the ratio of hydride reactive groups and alkenyl reactive groups to optimize the degree of cross-linking in the green product. Moreover, the Examiner notes that the stated ratio appears to be consistent with that set forth in nearly every known reference on curable silicone compositions of this type.

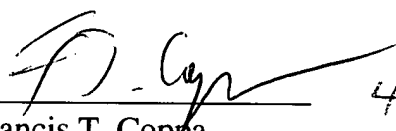
While Applicant has no specific knowledge as to the Examiner’s second point regarding the whole of the prior art, it is submitted that nothing in the Atwell reference itself suggests the particular hydride/alkenyl ratio of claims 2 and 31. The reference fails to suggest the presence or use of highly functionalized, low-viscosity silicone monomers/oligomers which have the specified ratio. Moreover, without any recognition of the need for such characteristics in components like casting cores and molds, one skilled in the art would not be expected to conceive of the specified ratio.

Claim 20 has been rejected under 35 U.S.C. 103, as being obvious in view of the Mine patent, as combined with either the Atwell patent or the Schilling patent, or a combination of all three references. The Examiner states that the practice of adding dispersing aids to facilitate the compounding of fillers into a host polymer matrix would be obvious. Applicant notes that the claim at issue specifically relates to the method for adding the dispersant, i.e., pre-mixing with the ceramic powder. Moreover, paragraphs 18 and 40 of the specification describe additional techniques regarding the use of the dispersant. This point is made to emphasize the notion that the use of the dispersant for this particular type of composition is not simply something routine in the art. (Applicant also notes that in some embodiments, the silicone monomers/oligomers can themselves function as the dispersant, so that no solvent is required). In summary, though, the limitation regarding incorporation of the dispersant, when viewed in conjunction with the other limitations in independent claim 18, should be seen as a demonstration that claim 18 is nonobvious in view of any combination of the cited references.

CONCLUSION

In conclusion, Applicant submits that the pending claims, with perhaps some very minor changes, should be judged as patentable over the applied references. (Applicant also acknowledges the mention of the MacDougald et al patent, U.S. 6,648,645, which has not been applied. The reference will be further analyzed and addressed if it is deemed necessary). The undersigned would be interested in discussing any remaining issues with the Examiner, if an interview might resolve those issues.

Respectfully submitted,

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